REPORT

on implementation of milestones of the 1st quarter of the third year
of the Joint Ukrainian-American Scientific Project

"Study of Thyroid Cancer and Other Thyroid Diseases in Ukraine Following the Chornobyl Accident"

(June 1998 - August 1998)

1. Management and administering

1.1 To complete equipping of the Data Coordinating Center (software and hardware) and Project Office (fax-machine, copyers).

Technical equipping of the Data Coordination Center has been mainly completed. Custom clearance of computers has been performed, and DCC has received the equipment by the end of August. Copyer (xerox) has been installed and is operating in Epidemiology Group. Fax-machine has been provisionally installed in DCC.

1.7 To organize in June,1998 a joint meeting of the Leaders of the Ministry of Public Health and Administration of the Ukr.-Am. Thyroid Project with participation of the main executors of the Project, on the basis of the Chernihiv Oblast Dispensary of Radiation Protection of the Population.

On June 24, 1998, on the basis of the Chernihiv Oblast Dispensary of Radiation Protection of the Population, a joint guest Conference of the leaders of the Ministry of Public Health of Ukraine together with the Administration of the Ukr.-Am. Thyroid Project has been organized and held, with participation of the main executorsof the Project.

1.8 To prepare all necessary custom documentation for the equipment received in the framework of the Project, make inventory of this equipment.

The necessary custom documents for equipment which is received according to the Project have been prepared, inventory of equipment has been made.

1.10 To perform preparatory work in order of screening of the cohort members who reside in Kozelets raion of Chernihiv oblast.

A preparatory work has been accomplished in order of screening of cohort members who are residing in Kozelets raion of Chernihiv oblast. Screening teams have begun screening in the town of Oster, Kozelets raion.

2. The establishment of the cohort

2.7 To continue entering the data from paper carriers, which have been obtained in controlled raions as a result of computer and manual search, into the database of the Project.

Were continued computer data entry of data, received as a result of manual search in Chernigiv oblast. On Kozelets raion Chernigiv oblast were entered data on 1020 persons (out of 2089 members of intensive cohort), which makes 48%. Out of them 720 currently live in Kozelrts raion. On Chernigov raion Chernigov oblast were entered data on 631 persons (out of 2858 members of intensive cohort), which makes 22%. Out of them 482 currently live in Chernigiv raion. Totally were entered data on 1651 persons. 1202 of them (72%) hasn't changed there place of residence.

The status of cohort members found as a result of manual search is distributed as follows:

Raions	Chernigov	Kozelets	Total
Found	482	720	1202
Not found	19	1	20
Moved to other oblast of Ukraine	10	5	15
Moved abroad	4	9	13
Moved in unknown direction	78	59	137
Temporarily absent in the settlement	11	19	30

Died	1	2	3
Dublicate	26	12	38
Temporarily lives in the settlement		193	193
Total	631	1020	1651

Received data on the results of manual search in Narodichi raion Zhitomyr oblasti. Were found 730 cohort members who currently live in Narodichi raion out of 4279 intensive cohort members, which makes 17%. It was found also that 690 subjects moved outside of the borders of Narodichi raion (16%). Status of the remaining cohort members is unknown. Data from hard copies are not entered yet that's why were not analyzed.

2.8 To make a computer analysis of verified data, which have been obtained on magnetic carrier, on the cohort members who reside in Ovruch raion of Zhytomyr oblast.

Were received renewed data on the diskettes on the results of search in Ovrutch raion Zhitomyr oblast. Were received data on 2747 cohort members, out of them :

Status	Number
found	2041
moved within the borders of Zhitomyr oblast	91
Moved to other oblast of Ukraine	284
Moved abroad	96
Moved in unknown direction	224
Died	11
Total	2747

3. **Invite the subjects for endocrinologic screening**

3.1 To ñîntinue invitations by the telephone of the cohort members currently living in Kyiv which were resettled from Chornobyl and Prypyat.

Continued invitation for screening of the patients who currently live in Kyiv and were resettled from Chornobyl and Pripiat. 40 persons gave their preliminary consent to take part in screening.

Period of time when invitations took place	Number of people Invited	Number of people examined	Subjects who were supposed to call back and didn't	Wrong ☎	Refused to come for examination	Telephone contacts: total
1.06-1.07	150	137	80	2	3	200
%	75	68,5	40	1	1,5	100

Out of 150 cohort members who agreed to come for examination, 137 persons or 91.3%, came for examination in the date of appointment.

3.2 To obtain consent to take part in screening from cohort members who reside in the town Ostior, Kozelets raion, Chernihiv oblast.

Local medical staff made contacts with the population of town Ostior of Kozeletskiy raion to get their preliminary concern to take part in the screening. There were difficulties in the process of obtaining concern because it was a vacation period and many possible cohort members were away for the recreation.

3.3 To publish in the Kozelets local newspaper an article clearing up the purposes of the screening of the population of Ivankiv raion in the framework of the Ukr.-Am. Project.

In the Kozelets local newspaper was published an article about the purpose and advantages of the examening in the framefork of the Project.

3.4 To give a broadcast talk on the local radio of Kozelets raion in order to inform the population about purposes and tasks of the Ukr.-Am. Thyroid Project.

On the radio of the Kozelets raion was given a broadcast tolk on the Ukrainian-American thyroid project.

3.5 On the basis of the information received on consent to take part in the screening, to make a schedule of screening of the population of the town Ostior, Kozelets raion, and Kyiv, resettled from Chornobyl and Prypyat.

Local medical staff based on the information on preliminary consent made up a schedule of examining of the population of Ostior Kozelets raion. The schedule of examination of cohort members who live in Kyiv, was made based on the results of telephone contacts.

4. **The endocrinologic examination of the subjects**

4.3 To continue screening of cohort members who have been resettled from Chornobyl and Prypyat to Kyiv.

4.4 To begin screening of cohort members who reside in the town Ostior, Kozelets raion, Chernihiv oblast.

In the reported period, clinical screening of thyroid diseases have been continued by stationary team in subjects who had been evacuated in April 1986 from the radioactive contamination zone (town of Prypyat) and are residing today in Kyiv.

137 persons (71 males and 66 females) have been examined in June 1998. Diffuse goiter, grade 1 has been revealed in 12 persons; diffuse goiter; grade 2 in two of the persons examined.

A mixed goiter, grade 2, a nodule of left thyroid lobe have been revealed in one of the persons examined. FNAB of nodule has been performed. Cytologic study of punctates corresponded to a follicular adenoma with signs of proliferation. Surgical treatment was proposed to this patient, which he flatly refused. A new examination has been fixed for September 1998.

In July-August 1998 the work of the team was interrupted due to summer holiday.

In June 1998 examinations have been performed by mobile teams in Ivankiv raion of Kyiv oblast on the basis of the Ivankiv Central Raion Hospital (American participants in the Project have acquainted themselves with the work of the mobile team on the spot on June 3, 1998. There were no remarks concerning the work of the mobile team from the American colleagues), and in Kozeletsky raion of Chernihiv oblast on the basis of the Kozelets Central Raion Hospital.

221 cohort members have been examined.

The following pathology has been revealed:

Diffuse goiter, grade 1: in 20 persons examined.
Nodular goiter, grade 1: in 4 persons examined.
Multinodular goiter, grade 2: in 3 persons examined.
Autoimmune thyroiditis: in 5 persons examined.
Post-operative hypothyroidism: in 3 persons examined.

5. The operation of the Central Laboratory

5.2 To perform all the laboratory tests in the process of screening.

During the reported period, kits and reagents for hormonal assays have not been received. Iinvestigations of blood content of calcium have been performed in screening participants.

Determination of urinary iodine (Turchin V.)

Determination of urinary iodine has been performed in 293 persons. In order to control the quality of laboratory analyses of iodine contents in urine, a part of determinations (80 samples) was performed, simultaneously with the Institute, at the Coordination Center of the World Health Organization at the Medical University in Poznan, Poland.

Determination of iodine contents in urine was performed using spectrophotometric method according to Wawschinek. This method is based on the oxidation-reduction reaction with arsenic, iodine and cerium, which proceeds according to the following formula:

$2Ce^{4+}+2I^{-} \square 2Ce^{3+}+I_2$

$I_2+As^{3+} \square As^{5+}+2I^{-}$

As a result of the reaction, depending on iodine contents, a yellow staining was noted. The quantitative index of the colour reaction was determined on a spectrophotometer CECIL 1010 at a wave length of 405 nm. Iodine concentration was determined after a graph plotted on the basis of the reaction of standard iodine solutions.

According to WHO recommendations, the indices of iodine urinary excretion given in Table 1 are considered as generally adopted norms.

Table 1. Epidemiological criteria for assessment of iodine deficiency according to the level of iodine urinary excretion

Mean indices (mcg/l)	Degree of iodine deficiency
< 20	Important
20 -49	Moderate
50 - 99	Weak
> 100	No deficiency

The results of iodine determination are presented in Table 2.

Table 2. Indices of iodine urinary excretion in the subjects examined

Iodine urinary concentration in patients examined (mcg/l)	Number of persons examined	%
< 20	88	30,03
20 - 49	135	46,07
50 - 99	38	12,97
> 100	32	10,93
Total: 293		

Thus, preliminary data of epidemiological study point out that a great part of the persons examined - 76.1 % - are under conditions of moderate and important iodine deficiency.

6. The operation of Data Coordinating Center

6.1 To receive equipment according to the Protocol. Installation of the local network and software.

- The fax-machine Minolta has been installed on fax number 4328511
- Sorfware Laser-FAX has been installed for image scanning using the fax-machine.
- MINOLTA PagePro12 printer has been installed. Adjustment of TCP/IP protocol for operation with printer on the network. Installation of LPR SPOOLER software for printing documents on the network under TCP/IP protocols.
- Adjustment of TCP/IP protocol of printer, installation of a network into the printer for operation on the network.
- Installation of printer's drivers according to operation systems W'95 and Win NT4.0.
- Installation of copyer MINOLTA.
- 100Mb/s - network for 8 operator's positions and a Patch-panel for 8 ports have been installed.
- a Netelligent 100 TX Repeater has been installed and connected up to the Patch-panel.

- Installation of ProSignia 200 server and its connection to the network.
- Installation of two SCSI-hard disks 4 Gb and magnetic-optical driver into the server
- Installation of software Compaq Insite manager and Compaq smart Start for server configuration.
- Installation of Win NT4.0 Server operation system.
- Installation of network adapter and network protocols.
- Determination of network shared resources on the server and permissions of users for Windows NT4.0 server operation system.
- Transfer of existing databases, of all documents and programmes from old personal computers to the server.
- Installation of 3 workstations Deskpro4000S (P200; 32 RAM; 3.1Gb; 15").
- Connection of stations to the network.
- Installation, as a client's software Windows 95 operation system on workstations.
- Installation of MS-Office-97.

6.2. Installation, studying and management of the database InterBase server.

- Software Delphi 3.0 and database management system (DBMS) InterBase has been received. DBMS InterBase has been installed on the server under Windows NT4.0 operation system.
- Since not all the equipment has been installed, a part of the milestone is postponed to the following quarter.

6.3. Recompilation of available databases into InterBase format.

- DataBases have not been transferred into InterBase format.

6.13. To work out a complex of programs for the Pathology Group operation.

- Due to late receipt of the equipment necessary for implementation of this milestone, it will be accomplished in the following quarter.

- In connection with absence of a local network between DCC and Pathology Group, this milestone has not been accomplished.

7. Pathology support for diagnosis of various forms of thyroid pathology.

7.1. To continue collecting and pathological examination of morphologic material from all patients born in 1968 and later from cohort oblasts and having been operated at the Institute of Endocrinology for different thyroid diagnoses. Pathomorphologic analysis of collected material.

Collection of biopsy material has been continued in the form of paraffin blocks and histological preparations from patients born in 1968 and later, who reside in Kyiv oblast (including city of Kyiv), Chernihiv, Zhytomyr oblasts and have been operated at the Clinic of the Institute of Endocrinology during the reported period for different types of thyroid pathology. A number of cases from the above oblasts, which were provided to the Laboratory by other clinics for consultative conclusions, have been added. For the period June-August 1998, material from 27 cases of surgical thyroid pathology has been collected. They include 10 cases of thyroid carcinoma (2 cases from Kyiv oblast, 4 from Chernihiv oblast and 4 from Zhytomyr oblast)); 4 cases of follicular adenoma (3 from Kyiv oblast and one from Chernihiv oblast); 7 cases of nodular goiter (4 from Kyiv oblast among which one goiter has been removed in a patient (female) evacuated from the city of Prypyat, and 3 from Chernihiv oblast); 3 cases of multinodular goiter (2 from Kyiv oblast and one from Chernihiv oblast); and 3 cases of diffuse toxic goiter (one from Kyiv oblast, one from Chernihiv oblast, and one from Zhytomyr oblast).

With diagnostic purpose, 140 blocks have been embedded in paraffin, and about 300 histological preparations have been studied at light microscope.

All the studied cases of thyroid cancer represented a papillary carcinoma. 5 tumors of this type were removed in children aged up to 15 years (one child belonged to the group of exposed in utero, the others were aged, at the time of the accident, from 8 months to 4

years). One case took place in an adolescent aged 18 years, and 4 tumors were removed in young adult patients aged 20 to 28 years.

As to their histological structure, the tumors in children had a mixed papillary-solid or papillary-follicular structure in 3 cases and represented diffuse-sclerosing variant of papillary carcinoma in 2 cases. It should be noted that in 4 from 5 cases in children, metastases in regional lymph nodes were reported.

A follicular variant of papillary carcinoma with presence of metastases in lymph nodes has been identified in one adolescent. In adult patients in 3 cases carcinomas had a typical papillary structure, and in one case there were signs of mixed solid-follicular growth. No metastases have been identified in adult patients.

Follicular adenomas, with dominant microfollicular-solid structure, with signs of oxyphilic-cell proliferation took place in 3 children aged 13 to 14 years and in one adult patient (female) aged 24 years.

Nodular and multinodular goiters have been identified in 6 children (one of which has been removed in a child born in 1987) and in 4 adult patients. They had a dominant macro-normofollicular structure with presence of cystic cavities. Only in one child multinodular goiter had an oxyphilic-cell adenomatous structure.

Diffuse toxic goiter was verified in 2 children and one adolescent.

7.2. Preparation of additional histological specimens for the morphologic data bank of the Ukr.-Am. Project from patients including in the cohort.

A detailed information on the above cases, which included patient's passport data, exact date of birth, place of residence during the accident and at the present moment, has been provided to the Dosimetry Department of the Scientific Center of Radiation Medicine and to DCC in order to identify persons who had direct measurements of thyroid activity and were included in the cohort. It has been established that from 27 subjects who have been operated within the reported period, 2 children belonged to the cohort under study. One of them, a girl born in 1984 (group "B"), who were living during the accident in the Polisya raion

of Kyiv oblast, had a nodular macrofollicular goiter with presence of a cystic cavity, and another girl born in 1985 from the city of Chernihiv (group "B") had a multinodular oxyphilic-cell adenomatous goiter. Additional histological preparations have been prepared from the paraffin blocks of the above goiters for the morphologic data bank of the Ukr.-Am. Project.

A female aged 22 years with a papillary carcinoma (exposure dose 141.5 cGy), who is residing in the Korosten raion of Zhytomyr oblast, also had direct measurements of thyroid activity. However, this raion of Zhytomyr oblast is not under study.

Thus, in the morphologic data bank of the Ukr.-Am. Project, among the cases identified in the cohort, at the present moment 22 cases of thyroid carcinoma remained unchanged (9 belonged to the group "C", 4 to the group "B", and 9 to the group "A"); in addition, in 3 cases paraffin blocks and histological preparations are missing, and in one case paraffin blocks are missing (these patients having been operated in other clinics).

2 cases have been added to the cases of benign pathology revealed among the persons identified in the cohort. Thus, at the present moment, 8 cases (2 follicular adenomas, 3 multinodular goiters, 2 nodular solitary goiter, and one diffuse toxic goiter) have been registered.

7.3. To ensure intraoperational diagnosis, histological processing and pathomorphologic analysis of specimens received from patients selected for surgery after screening. Preparation of additional histological specimens for the morphologic data bank of the Ukr.-Am. Project.

Screening examinations performed to date allowed to identify patients with nodules in thyroid gland measuring less than 1 cm (according to USI data). According to FNAB results, these nodular formations had a benign character, and, therefore, these patients are followed up by endocrinologists without surgical intervention and further morphologic studies.

7.4 To fill in the Pathology Forms for the patients with revealed cases of thyroid pathology, included in the cohort under study. To set these data into the

computer and provide them to DCC (after receipt of computers).

After discussion of the Pathology Form with Professor V. LiVolsi, American expert-pathologist, at an International Symposium in Cambridge (July 1998), the latter has been still abridged. Since the computer equipment has not yet been received, the Forms for the above cases have been completed on paper.

8. Dosimetry support of the Project

8.16. CONTRIBUTION TO THE THYROID DOSE OF THE INTAKE OF RADIOCESIUM METHODOLOGY

8.16.1 Generalities

The method of calculation of doses of internal irradiation from cesium radioisotopes ingested with foodstuffs , is based on the methodology given in the instructional-methodical recommendations entitled "Reconstruction and prognosis of radiation exposure of the population residing in areas of Ukraine having been subject to radioactive contamination as a result of the Chernobyl accident" [1].

Reconstruction of internal irradiation doses for cohort members is provided for in the form of average "referent" doses for the settlement (S) where the cohort member was residing in each calendar year for the period 1986 to 2000.

The models (and estimates of their parameters) of internal irradiation from cesium radioisotopes were constructed as applied to adult population and extrapolated to children's population, differences between children's and adult's being "overlapped" by conservatism of dose estimates.

When obtaining estimates of referent doses, models have been developed for the following types of settlements (according to official data on administrative-territorial division of Ukraine):

- "village" – rural settlements;
- "sut" - settlements of urban type;
- "small cities" which include raion centers, and cities of raion subordination;
- "large cities" which include oblast centers, including the city of Kyiv, as well as cities of oblast subordination.

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8.16.2 Methodology of calculation of "referent" doses for settlements.

The methodology of calculation of "referent" dose of internal irradiation for villages, "sut", small and large cities is presented in [1].

For "village" and "sut", and for the period 1987 to 2000, the method is based on use of the following model functions and coefficients:

- the "milk" function, normalized per a unit of density of ^{137}Cs fall-outs on soil and describing changes in the time of ^{137}Cs concentration in milk and relationship to the value of "referent" coefficient of transition of radiocesium from soil to milk;

– the "referent" milk equivalent of the ration, which allows to express the daily radiocesium consumption with different foodstuffs of ration through the level of consumption of milk of local production, estimated as equal to 0.97 l/day for the milk of local production;

- the dose coefficient (of effective dose) for ^{137}Cs assumed as equal to 1 10^{-8} Sv per Bq of intake, and dose coefficient for ^{134}Cs assumed as equal to 1.4 10^{-8} Sv per Bq of intake.

In 1986 the mechanism of radioactive contamination of vegetation and the process of forming of internal irradiation doses as a result of consumption of foodstuffs contaminated with radiocesium, significantly differed from those for the following years after the accident. The assessment of doses of internal irradiation from ^{137}Cs and ^{134}Cs for the first year after the accident was performed with maximum involvement of humans' counter measurements of radiocesium content in the organism of the inhabitants. The "referent" milk equivalent of ration, estimated in that way, for ^{137}Cs in 1986 was found to be equal to 14.3 l/24 h, and the normalized "referent" dose of internal irradiation for 1986 from cesium radioisotopes equal to 9.4 uSv per kBq/m^2.

In the process of assessment of the referent doses of internal irradiation from ^{137}Cs and ^{134}Cs in city dwellers, the following assumptions have been adopted:

- independence of the referent dose on the radioecological characteristics of areas surrounding the city in question because of a low proportion in ration of foodstuffs produced in the private sector, and because of a high level of radiation monitoring of foodstuffs;
- a diet and a relationship between the decrease of referent dose and time, which are common for all cities of the same type.

For the calendar years from 1987 to 2000, the "referent" annual effective dose of internal irradiation from cesium radioisotopes for villagers is determined by the following formula:

$$E_{Cs}^{Rur}(t)=\sigma_{Cs}^{0}\times\left(k_{Cs}^{0}\right)^{0.85}\times\tilde{E}_{Cs}(t), \quad (1)$$

where $E_{Cs}^{Rur}(t)$ is the annual effective dose of internal irradiation for a villager in 1987-2000, μ Sv;

σ_{Cs}^{0} are values of density of soil contamination with ^{137}Cs, averaged for the territory of settlement and its environs, obtained as a result of monitoring in 1992 (or corrected to 1992 taking into account the radioactive decay of ^{137}Cs), kBq/m^2;

k_{Cs}^{0} is the value of the coefficient of transition of ^{137}Cs from soil to milk determined as the relationship between the value of ^{137}Cs concentration in milk, averaged for 1991-1993, and the value of σ_{Cs}^{0}, (Bq/l)/(kBq/m^2);

$\tilde{E}_{Cs}(t)$ is the "referent" dose of internal irradiation from ^{137}Cs ^{134}Cs (the latter influences the forming of the dose only in the first 5-7 years after the accident), normalized for a unit of density of ^{137}Cs fall-outs on soil and for a unitary coefficient of transition of ^{137}Cs from soil to milk; models and parameters for calculation of the normalized "referent" dose are presented in [1]

- t is the calendar year t={1997 ...2000}.

The results of calculation are presented in Table 1.

Table 1 – Referent doses of internal irradiation from cesium radioisotopes ,E,Cs(t) normalized for 1 kBq/m^2 of density of ^{137}Cs fall-outs on soil, for areas with referent value of coefficient of transition of ^{137}Cs from soil to milk 1 (Bq/l)/(kBq/m^2).

Year	Referent normalized dose of internal irradiation in uSv per kBq/m^2 per (Bq/l)/(kBq/m^2)
1987	11
1988	7.9
1989	5.9
1990	4.6

1991	3.6
1992	2.9
1993	2.9
1994	2.3
1995	1.9
1996	1.6
1997	1.4
1998	1.2
1999	1.0
2000	0.88

For 1986 the "referent" annual effective dose of internal irradiation from cesium radioisotopes for villagers is determined by the formula:

$$E_{Cs}^{Rur}(86)=\sigma_{Cs}^{0} \times 9.4, \qquad (1)$$

where $E_{Cs}^{Rur}(86)$ is the effective dose of internal irradiation for a villager in 1986, μSv;

σ_{Cs}^{0} are values of density of soil contamination with ^{137}Cs, averaged for the territory of settlement and its environs, obtained as a result of monitoring in 1992 (or corrected to 1992 taking into account the radioactive decay of ^{137}Cs), kBq/m^2;

9.4 is the value of referent normalized dose of internal irradiation from cesium radioisotopes for 1986 for villagers, uSv.

The normalized referent dose of internal irradiation from cesium radioisotopes for inhabitants of "sut" ($\tilde{E}_{Cs}^{sut}$) makes 0.5 from the normalized referent dose $\tilde{E}_{Cs}$ for villagers for the same year:

$$\tilde{E}_{Cs}^{sut}=0\text{þ}.5\times\tilde{E}_{Cs} \qquad (2)$$

The further procedure of calculation of referent doses of internal irradiation from cesium radioisotopes for "sut" does not differ from the procedure of calculation of the same dose for villages.

The values of doses obtained using this methodology have a certain reserve of conservatism connected with the following circumstances:

- the decrease of dose due to short-term departures of inhabitants from contaminated areas in 1986-1987, is disregarded;
- the protective effect connected with restrictions and self-restrictions for consumption of local foodstuffs, which took place in countryside, is not taken into account;
- for every age, one adopts a consumption for an adult person, which ensures a two(three)-fold reserve of conservatism for the dose of internal irradiation from radiocesium.

The values of annual doses of internal irradiation from cesium radionuclides in inhabitants of large and small cities of Ukraine according to estimates [1] are given in Table 2.

Table 2 – Values of annual doses of internal irradiation from cesium radionuclides in inhabitants of large and small cities of Ukraine [1]

Annual doses, μ Sv		
Year	Large cities	Small cities
1986	264	510
1987	89	263
1988	48	155
1989	38	106
1990	34	82
1991	32	69
1992	30	62
1993	28	56
1994	27	53
1995	25	49
1996	24	46
1997	23	44
1998	22	42
1999	21	40
2000	20	38

8.16.2 Basic information for calculation of doses from absorbed radiocesium.

- One uses as basic information for assessment of doses of internal irradiation from radiocesium for a cohort member:
  - questionnaire data on settlement where the cohort member was residing in each calendar year (stay in settlement during 6 months and more is taken into account);
  - the values of density of soil contamination with ^{137}Cs (σ^0_{Cs}), averaged for the territory of settlement and its environs, obtained as a result of monitoring in 1992 (or corrected to 1992 taking into account radioactive decay of ^{137}Cs); information is contained in the data bank of the Department of Dosimetry and Radiation Hygiene of the Center for Radiation Medicine;
  - the value of the coefficient of transition of ^{137}Cs from soil to milk (k^0_{Cs}), determined as the relationship between the value of ^{137}Cs concentration in milk averaged for 1991-1993 and the value σ^0_{Cs}; information is contained in the dosimetry data bank of the Department of Dosimetry and Radiation Hygiene of the Center for Radiation Medicine;
- the results of calculation of "referent" normalized doses of internal irradiation from cesium radioisotopes (Table 1 and Table 2).

8.17 CONTRIBUTION TO THE THYROID DOSE OF THE EXTERNAL EXPOSURE FROM DEPOSITED RADIONUCLIDES: METHODOLOGY

8.17.1 Generalities

The method of calculation of doses of external exposure from Chernobyl radionuclides, fallen out on the soil, is based on the methodology given in the instructional-methodical recommendations entitled "Reconstruction and prognosis of radiation exposure of population residing in areas of Ukraine having been subject to radioactive contamination as a result of the Chernobyl accident" [1].

Reconstruction of internal irradiation doses for cohort members is provided for in the form of "referent" doses for the settlement (S) where the cohort member was residing in each calendar year for the period from 1986 to 2000, and age reached by the cohort member for each calendar year.

In the process of assessment of referent doses, models have been developed for the following types of settlements:

- "village" – rural settlements;
- "sut" - settlements of urban type;

- "city" - cities.

In the process of assessment of doses of external irradiation, two age groups of children and one age group for adults are selected, and one takes into account the age reached by the member of the cohort under observation in each calendar year:

- children aged 0 to 7 years;
- children aged 8 to 17 years;
- adults aged over 18 years.

8.17.2 Methodology of assessment of doses of external gamma-exposure from radionuclides fallen out on the soil

The methodology of calculation of the "referent" dose of external gamma-exposure is presented in [1].

The dose estimates for external irradiation are based on the values of the calculated, normalized to the levels of density of soil contamination with ^{137}Cs (σ^0_{Cs}), "referent" dose of external gamma-exposure $\tilde{E}_{ext}(t,gr,TS)$, accumulated for each calendar year for the period 1986 to 2000 and depending on the calendar year (t), age group (gr), and type of settlement (*TS*). The dose of external gamma-exposure is determined from the relationship:

$$E_{ext}(t,gr,TS) = \sigma^0_{Cs} \times \tilde{E}_{ext}(t,gr,TS) \qquad (3)$$

In the process of modeling of "referent" dose of external gamma-exposure $\tilde{E}_{ext}(t,gr,TS)$, one takes into account:

- The integral of "referent" rate of the absorbed dose in air per unit of activity of each of 19 Chernobyl radioisotopes in question:
- The "referent" relationship between radioactivity of each from 18 radionuclides and ^{137}Cs in fall-outs;
- The time kinetics of the radionuclides forming radioactive chains;
- The function of reduction of the rate of the accumulated dose in air for ^{137}Cs and ^{134}Cs taking into account the vertical migration of radionuclides deep into the soil;
- The "coefficient of regimen of behavior" determining the relationship between the real dose for a given time interval, received by inhabitants of settlements, and the exposure dose which the inhabitants of this settlement would have received during all the period in question if they were on an open area; this coefficient depends on age and type of settlement;
- The coefficient of transition from the absorbed dose in air to the effective dose of uniform irradiation of the human body (Sv/Gy).

The results of calculation are given in Table 3.

8.17.2 Basic information for calculation of doses from external gamma-exposure.

As a basic information for assessment of doses of external irradiation for a cohort member, one uses:

- questionnaire data on settlement where the cohort member was residing in each calendar year (stay in settlement during 6 months and more is taken into account);
- the values of density of soil contamination with ^{137}Cs (σ^0_{Cs}), averaged for the territory of the settlement and its environs, obtained as a result of monitoring in 1992 (or corrected to 1992 taking into account the radioactive decay of ^{137}Cs); information is contained in the data bank of the Department of Dosimetry and Radiation Hygiene of the Center for Radiation Medicine;
- the results of calculation of annual normalized doses of external gamma irradiation (Table 3).

Table 3 – Values of annual normalized doses of external gamma-exposure for age groups and types of the settlements considered.

	Rural settlements	Settlements of urban type	Cities

	<=7 y	8-17 y	>=18 y	<=7 y	8-17 y	>=18 y	<=7 y	8-17 y	>=18 y
1986	12.3	15.1	27.4	9.1	11.2	20.3	5.9	7.2	13.2
1987	4.5	5.6	10.2	3.4	4.1	7.5	2.2	2.7	4.9
1988	3.1	3.8	6.9	2.3	2.8	5.1	1.5	1.8	3.3
1989	2.4	3.0	5.4	1.8	2.2	4.0	1.2	1.4	2.6
1990	1.9	2.4	4.3	1.4	1.8	3.2	0.9	1.1	2.1
1991	1.6	2.0	3.7	1.2	1.5	2.7	0.8	1.0	1.8
1992	1.4	1.8	3.2	1.1	1.3	2.4	0.7	0.8	1.5
1993	1.3	1.6	2.9	0.9	1.2	2.1	0.6	0.8	1.4
1994	1.2	1.4	2.6	0.9	1.1	1.9	0.6	0.7	1.3
1995	1.1	1.3	2.4	0.8	1.0	1.8	0.5	0.6	1.2
1996	1.0	1.2	2.2	0.7	0.9	1.6	0.5	0.6	1.0
1997	0.9	1.1	1.9	0.6	0.8	1.4	0.4	0.5	0.9
1998	0.8	1.0	1.8	0.6	0.7	1.4	0.4	0.5	0.9
1999	0.8	0.9	1.7	0.6	0.7	1.3	0.4	0.5	0.8
2000	0.7	0.9	1.6	0.5	0.7	1.2	0.3	0.4	0.8

8.7 To support the questionnaire DB. Questioning, input and computer support of questionnaires's information. Dose reconstruction on the basis of questionnaire data.

In the first quarter of the third year of the Project 178 persons have been questioned (all of them are cohort members); among them 42 inhabitants of Ivankiv raion of Kyiv oblast, 105 inhabitants of Kozelets raion of Chernihiv oblast, and 31 former inhabitants of the city of Prypyat. Among the above 178 persons 153 were subjects who were aged under 10 years at the moment of the accident (36 persons for the Ivankiv raion, 93 persons for the Kozelets raion, and 24 persons for the city of Prypyat).

In SUBD Microsoft ACCESS a DB has been created for input and storage of questionnaires' information in electronic form, which includes input forms. Input into DB of all questionnaires collected within the reported period has been performed. In addition, all the questionnaires collected in the previous quarter have been also set into DB.

The total number of questionnaires set into DB and their distribution for different regions (for September 1, 1998) are given in
Table 8.7.1.

Table 8.7.1

Location of the persons questioned during the Chernobyl accident	Number of questionnaires in DB	Including number of questionnaires of cohort members
City of Prypyat	107	104
Ivankiv raion of Kyiv oblast	182	177
Kozelets raion of Chernihiv oblast	105	105
TOTAL	394	386

8.15. VERIFICATION OF THYROID MEASUREMENTS. DISTRIBUTION OF THE NUMBER OF DOSE ESTIMATES ACCORDING TO THE DEGREE OF RELIABILITY. LIST OF PROBLEMS TO BE SOLVED.

8.15.1. Restoration of devices' serial numbers for lists with missing information on device's number

Among 1087 lists representing the file of thyroid activity measurements, in 119 lists information on measuring device's serial number was missing, what makes difficult the procedure of analysis of operate reliability of devices. However, information on device's number may be reconstructed after available indirect data: dosimetric team's number, dosimetrist's name, place of performing measurement, etc.

The results of restoration of devices' serial numbers for lists with missing information on device's serial number are given in Table 8.15.1.

Table 8.15.1.

Results of restoration of devices' serial numbers for lists with missing information on device's number.

Device	Serial numbers restored	Number of lists for which serial N has been restored	Oblast where measurements have been made
DSU-68	14	10	Chernihiv oblast
NK-150	71077	6	Chernihiv oblast
SRP 68-01	149	2	Zhytomyr oblast
	268	4	Zhytomyr oblast
	282	1	Khmelnitsky oblast
	906	1	Chernihiv oblast
	1119	1	Crimea
	1143	8	Kyiv oblast
	1757	2	Crimea
	1784	1	Khmelnitsky oblast

In the process of work, we have selected the cases where a group of lists contained the results of measurements which have been made undoubtedly by one device, but we have no possibility to link this device with one of devices having a serial number. In such cases, one has attributed to the device found a number which differs from all existing ones. In all, 5 numbers have been attributed to devices of 3 types (Table 8.15.2).

Table 8.15.2

Devices for which serial numbers have been attributed

Device	Serial number attributed	Number of lists with measurements made by the device	Oblast where measurements have been made
NK-350	1	14	Crim ea
NK-150	3	11	Kyiv oblast
NK-150	4	1	Sumy oblast
SRP 68-01	1001	4	Crimea
	1002	1	Zhytomyr oblast

8.15.2. Distribution of devices and dose estimates according to the degree of reliability of measurements performed.

After restoration of devices' serial numbers for lists with missing information on device's serial number, an analysis has been made of measuring device's reliability of all the devices which have been used for thyromonitoring of devices.
According to their construction and calibration features, devices have been divided into 3 classes:

1. Non spectrometric devices of SRP type, for which calibration data were missing and a calibration factor equal to $6.25*10^{-3}$ μCi μR^{-1} h. was used in calculations;
2. Non spectrometric devices of SRP type, for which data of results of devices' calibration according to control source of ^{131}I were available (formerly taken into account or restored from lists in the process of verification of results of measurements);
3. Spectrometric devices, for which the lists always contain either calibration factors calculated by the dosimetrist having made measurements, or the results of measurements of control source of ^{131}I, after which calibration factors may be calculated.

The devices of the first class selected were referred to the devices with insufficient reliability because of an inaccurate calibration factor. The estimate of calibration factor for these devices is to be verified. The list of SRP devices' serial numbers with an insufficient reliability which has to be improved, is given in Table 8.15.3. For the devices referred to class 2 and 3, an index of calibration factor stability has been chosen as a criterion of operate reliability of the device. The following characteristics have been calculated:

- The mean factor $(\overline{C}_{sv})$ for sample of calibration factors $(C_{si}, i=1...n)$ from all (n) lists, made using a device with one serial number (s);
- The standard deviation (δ_s) for sample of calibration factors (C_{si}) in lists made using a device with one number;
- The factor of variation "Error !" which just served as a standard of stability of device's functioning. One assumed that for K_s >=20% , functioning of device with a given serial number is not stable, and results of calibration have to be verified (HBV).

For spectrometric devices, the following facts were taken into account:

- Counting time from source (t), which for a device with one number might vary from one list to another. Therefore, when grouping lists for calculations of a list with different time of measurement, separate subgroups have been formed. It should be noted that information on time of measurement is one of the most insufficient ones among primary data. In most of lists this information is always missing. Such lists for a device with a determined number were also selected in a separate subgroup.
- For the device UR 1-3, No. 912001, the only one among all devices which was used for measurements in different oblasts, a division of lists into subgroups has been performed according to the oblast where measurements were performed. This has been made suggesting that when one passed from one oblast to another, time of measurement might change, and information on time of measurement for this device was missing.
- For devices GTRM-01C with numbers No. 3981, No. 94, No. 93, and for devices DSU 2-1 with numbers 107037, 80910, the calculation of indices K_s makes no sense, because measurements were made according to a special method,

for which activity of source at the time of measurement represents the calibration factor. The functioning of these devices was recognized as reliable according to formerly performed investigations [1].

For SRP non spectrometric devices in which the results are given in the form of pulse counting rate per unit of time, the indices $\bar{C}_s$, δ_s K_s were calculated in the process of grouping the data according to device's serial number only.

The results of calculation of indices $\bar{C}_s$, δ_s K_s for all SRPs with calibration are presented in Table 8.15.4. Devices 59, 1820, 1670 with high K_s have been selected. The results of calibration of these devices have to be furtherly analysed and verified.

The results of calculation of indices $\bar{C}_s$, δ_s K_s for all spectrometric devices are given in Table. 8.15.5. Devices of NK-150 type 71070 71077, NK-350 type 81031 having operated in Chernihiv oblast, and device NK-350 76028 having operated in Crimea, with abnormally high K_s have been selected. As concerns these devices, one suggests that from one list to another not only time of measurement of control source was changing, but also the relationship between times of measurement of source and of thyroid gland. Unfortunately, information on relationship between these times in primary data is missing. Besides, just for these devices the calibration factor calculated by the dosimetrist in the process of measurements is not always indicated. All this points out the necessity of an additional verification of results of measurements using these devices, what is noted in Table 8.15.5.

Table 8.15.6 shows distribution of results of dose estimates for cohort members having been measured using devices recognized as insufficiently reliable ones (HBV) according to the regions of residence during the accident.

8.15.3. List of problems to be solved.

Among the investigations concerning verification of the results of measurements, we emphasize the following problems to be solved:

1. Development of a method of verification of calibration factors for devices with serial numbers, selected as HBV in Table 8.15.3-8.15.5.
2. Verification of calibration factors.
3. Estimation of contribution of ^{137,134}Cs in the results of measurements after comparison of the results of spectrometric and non spectrometric measurements on identical contingents.
4. Development of a method of reconstruction of data on time of measurement of source and of thyroid gland. Restoration of missing information on time of measurement.
5. Recalculation of values of minimally detectable activity taking into account verified data on time of measurement.
6. Reiterate assessment of operate reliability of devices using a modified method [1].
7. Recalculation of exposure doses using verified calibration factors.

UKRAINIAN - AMERICAN SCIENTIFIC PROJECT ON THE STUDY
OF CANCER AND OTHER THYROID DISEASES
IN UKRAINE FOLLOWING THE CHORNOBYL ACCIDENT

Tasks for the 2nd quarter of the 3rd year (September - November, 1998)

1	TASK	man*month
1	**Management and administration**	
1.9	To prepare continuation of the Agreement according to the Project.	0.5
1.10	To apply to the State Administration of the Kozelets raion of Chernihiv oblast in order of providing a coach for transporting cohort members for the period of screening.	0.5
1.11	To ensure printing of Examination Forms in a printing-house.	0.5
1.12	To organize and hold a regular joint meeting devoted to Project implementation (with participation of the Ministry of Public Health of Ukraine, Management and Co-executors of the Project).	1.0
1.13	To work with custom clearance documentation.	2.0
2	**Establishment of the cohort**	
2.7	To complete input of data from paper carriers, obtained as a result of manual search in Chernihiv and Kozelets raions of Chernihiv oblast.	3.0
2.9	To input data from paper carriers, obtained as a result of manual search in Narodychi raion of Zhytomyr oblast.	3.0
3	**Invitation of patients for endocrinologic screening**	
3.1	To ñîntinue invitations by the telephone of the cohort members currently living in Kyiv, who were resettled from Chornobyl and Prypyat.	1.0
3.6	To obtain consent to take part in screening from cohort members who reside in Ovruch raion, Zhytomyr oblast.	1.0
3.7	To publish in the Ovruch local newspaper an article clearing up the purposes of the screening of the population of Ovruch raion in the framework of the Ukr.-Am. Project.	0.5
3.8	To give a broadcast talk on the local radio of Ovruch raion of Zhytomyr oblast in order to inform the population about purposes and tasks of the Ukr.-Am. Thyroid Project.	0.5
3.9	On the basis of the information received on consent to take part in the screening, to make a schedule of screening of the population of Ovruch raion of Zhytomyr oblast, and of inhabitants of Kyiv who have been resettled from Chornobyl and Prypyat.	1.0
4	**Endocrinologic examination of the subjects**	
4.3	To continue screening by stationary team of cohort members who have been evacuated from Chornobyl and Prypyat to Kyiv.	7.0
4.5	To continue screening by mobile teams of cohort members who are residing in Ovruch raion.	7.0
5	**Operation of the Central Laboratory**	
5.2	To perform all the laboratory tests in the process of screening.	7.0
6	**Operation of Data Coordinating Center**	

6.1	To complete installation of software and hardware.	1.0
6.2	To complete study and management of the database InterBase server.	1.0
6.3	Recompilation of available databases into InterBase format.	1.0
6.13	To work out a complex of programs for the Pathology Group.	2.0
6.14	To work out a database and computer form of input of data for the Locator Form.	2.0
7	**Pathology support for diagnosis of various forms of thyroid pathology.**	
7.1	To continue collecting of morphologic material from all patients born in 1968 and later from cohort oblasts and having been operated at the Institute of Endocrinology for different types of thyroid pathology. Pathomorphologic analysis of this material.	6.0
7.2	Preparation of additional histological specimens for the morphologic data bank of the Ukr.-Am. Project (after identification of concrete patients included in the cohort).	1.0
7.3	To ensure intraoperational diagnosis, histological processing and pathomorphologic analysis of specimens received from patients selected for surgery after screening. Preparation of additional histological specimens for the morphologic data bank of the Ukr.-Am. Project.	1.0
7.4	To fill in Pathology Forms for cases of thyroid pathology revealed in patients who were included in the cohort. To input the data obtained into computer and provide them to DCC (after receipt of computers).	1.0
8	**Dosimetry support of the Project**	
8.15	Verification of thyroid measurements. Development of a method of retrospective assessment of "device"-specific ("list"-specific where it is possible) calibration factor for devices with missing calibration data.	12.0
8.7.	To continue dosimetry support of the questionnaire DB. Questioning, input and computer support of questionnaires' information.	12.0
8.18.	Preparation of an informational background for assessment of doses of external and internal (from ^{137,134}Cs) exposures for the cohort members. Creation of geocoded DBs of radioecological features for settlements of raions under study.	10.0